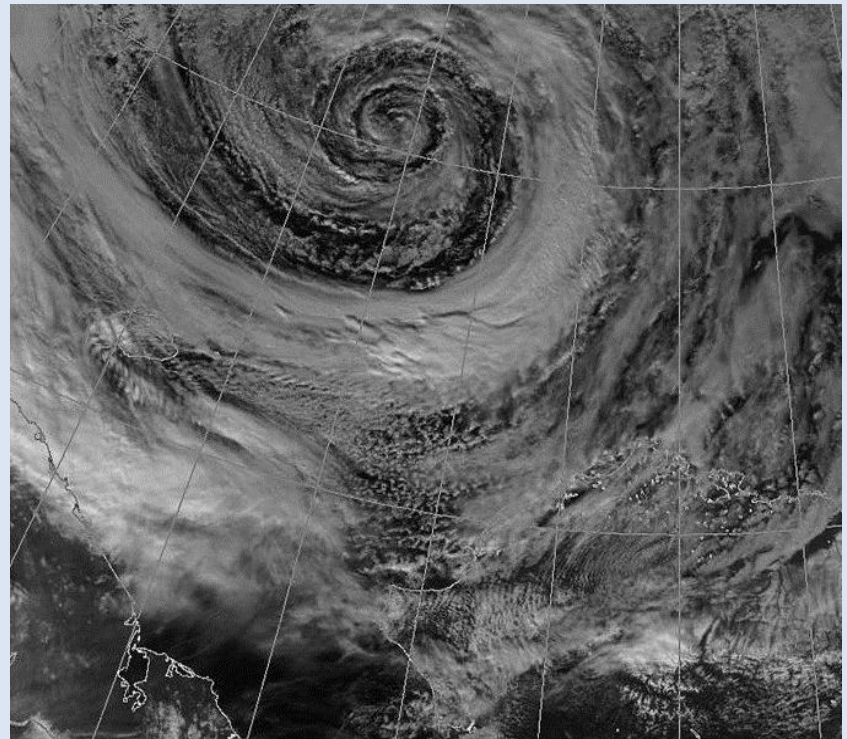
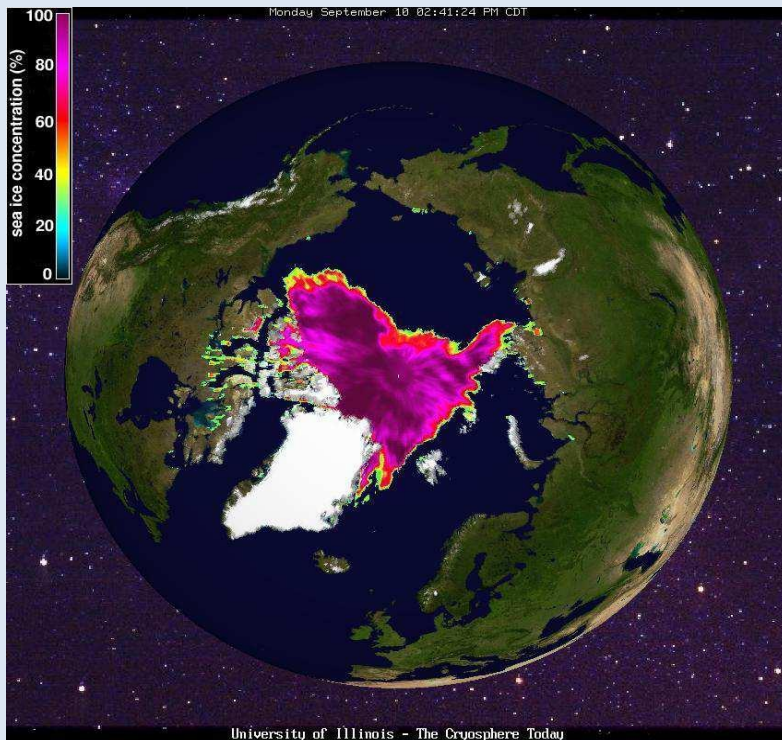


Linking Sea Ice Retreat and Impacts of Storms

John Walsh and William Chapman

Alaska Center for Climate Assessment and Policy (ACCAP)

University of Alaska, Fairbanks



Rates of coastal erosion and flooding are increasing in Alaska

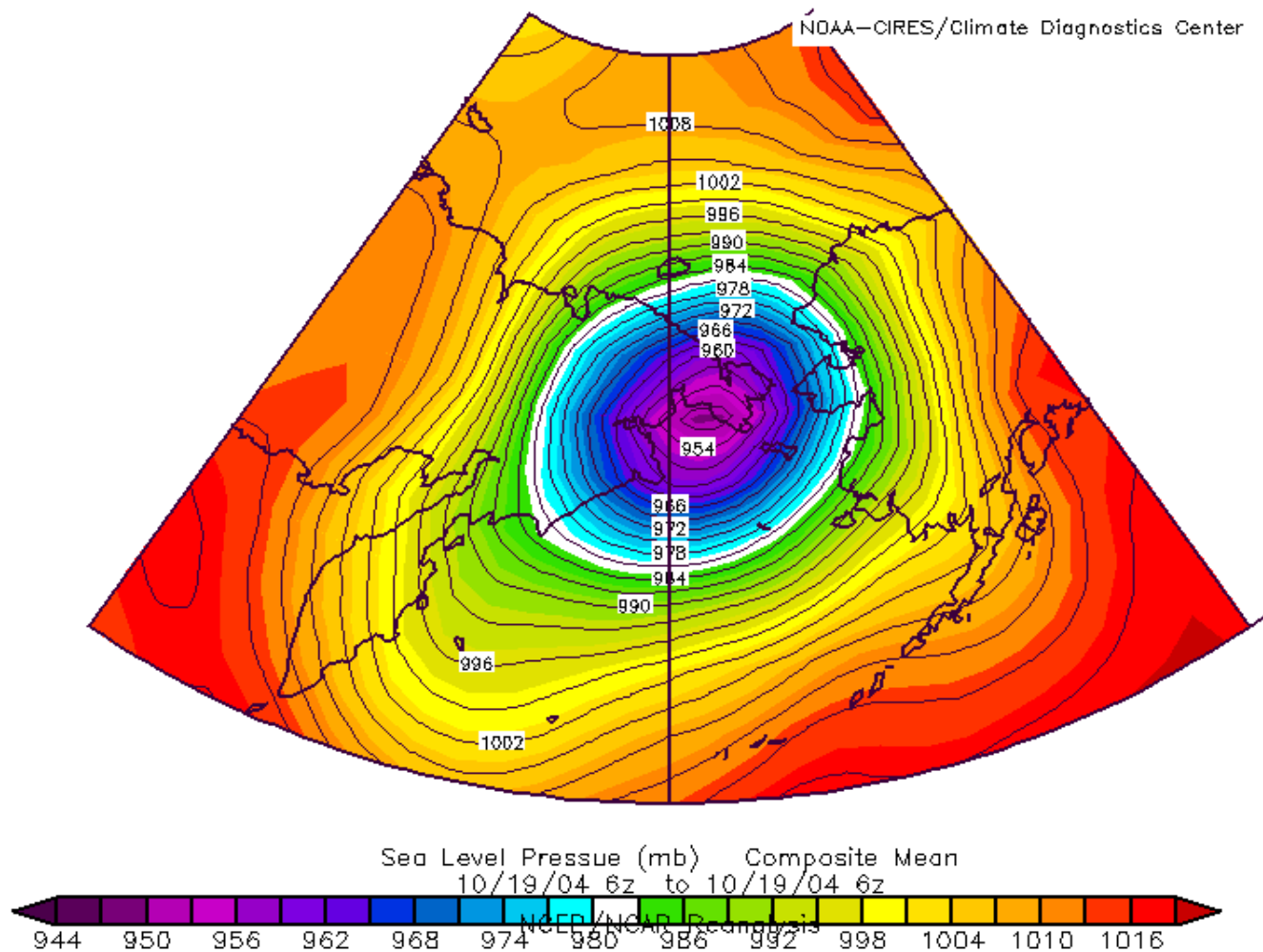
Several factors affect coastal vulnerability:

- **Frequency and intensity of storms**
- **Sea ice coverage in offshore waters**
- **Sea level**

Intense Arctic cyclone affecting Alaskan coast

Barrow

Extreme event: 941 mb cyclone, flooding of Nome, AK on 19 Oct 2004



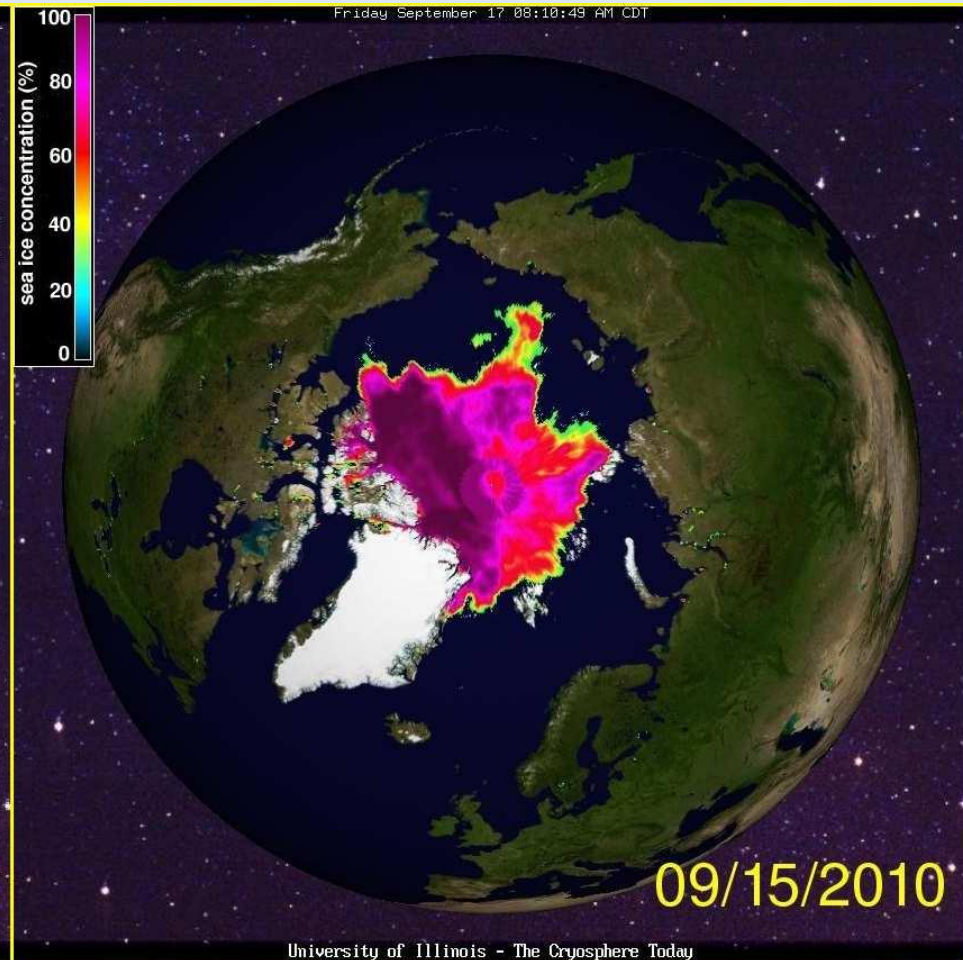
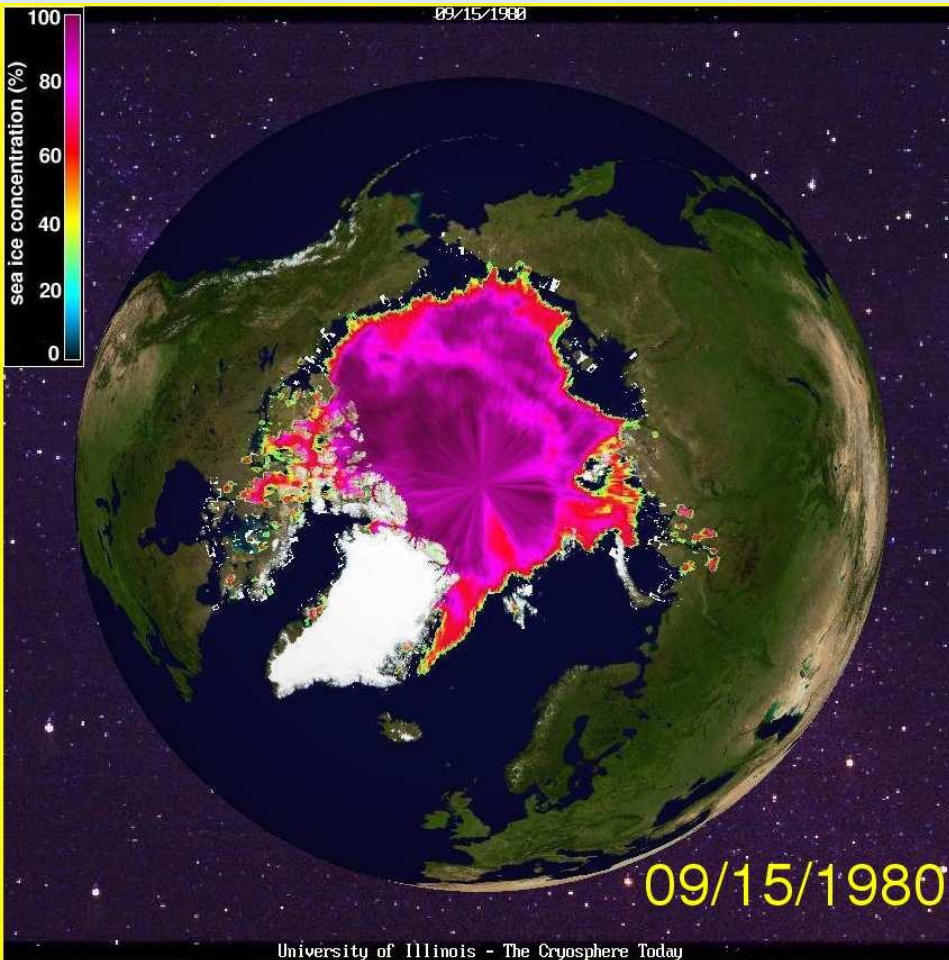
Front Street, Nome (photo by J. Steiger, WSO Nome)



Arctic sea ice concentrations

Sep. 15, 1980

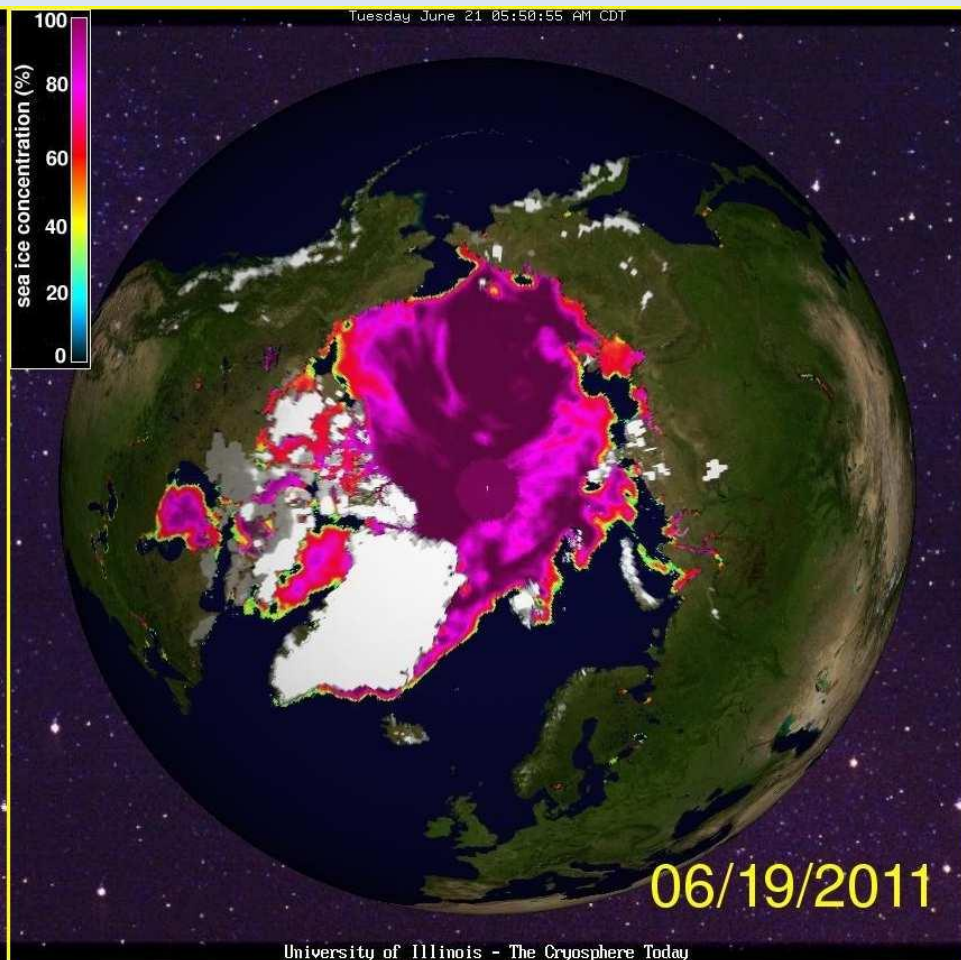
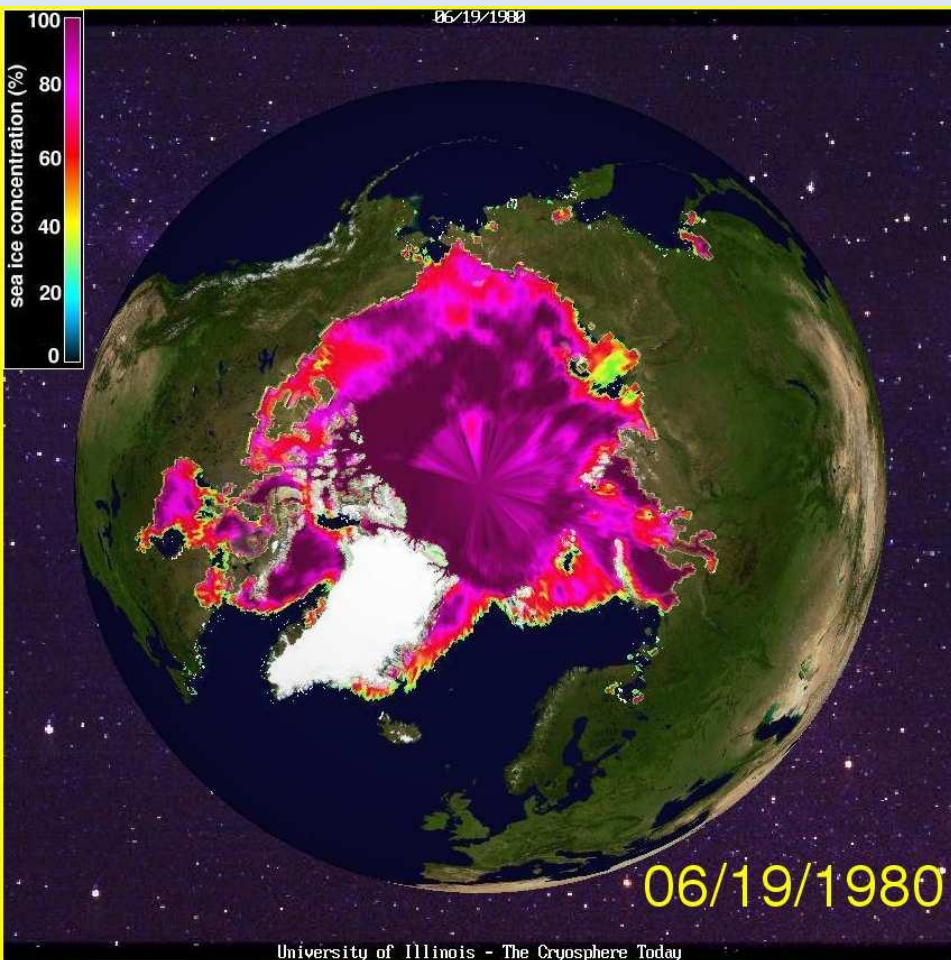
Sep. 15, 2010



Arctic sea ice concentrations

June 19, 1980

June 19, 2011



Why the recent increase in coastal flooding and erosion?

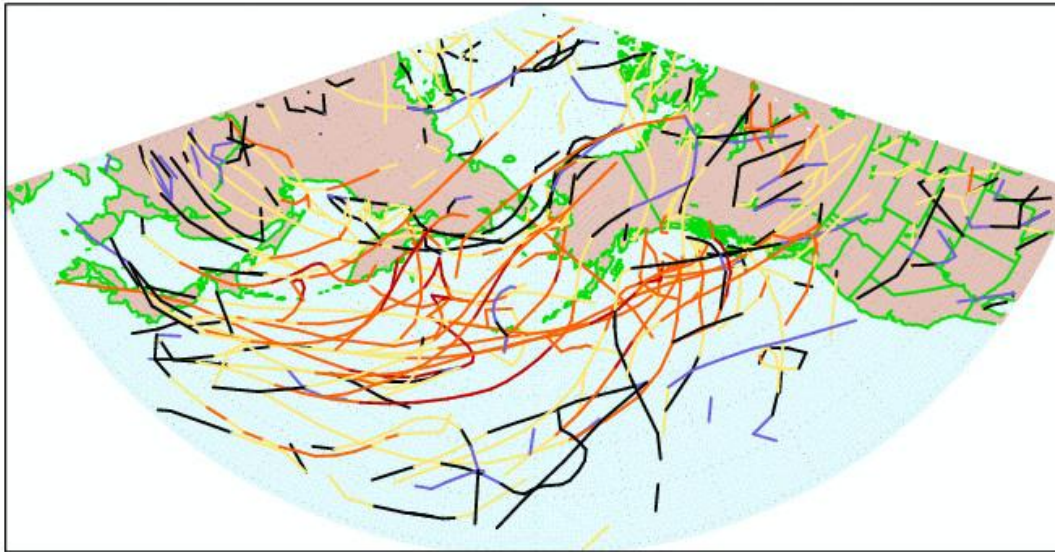
Hypothesis 1: Storminess has increased

Hypothesis 2: Coastal sea ice has decreased

Database on storms (cyclones) affecting Alaska

- **Global database of cyclone tracks compiled by Climate Prediction Center, National Centers for Environmental Prediction (J. Gottschalk)**
- **Based on NCEP/NCAR reanalysis, 1948-present**
- **6-hourly time increments**
- **Locations and central pressures of all low-pressure centers; tracking algorithm connects successive positions of storms**

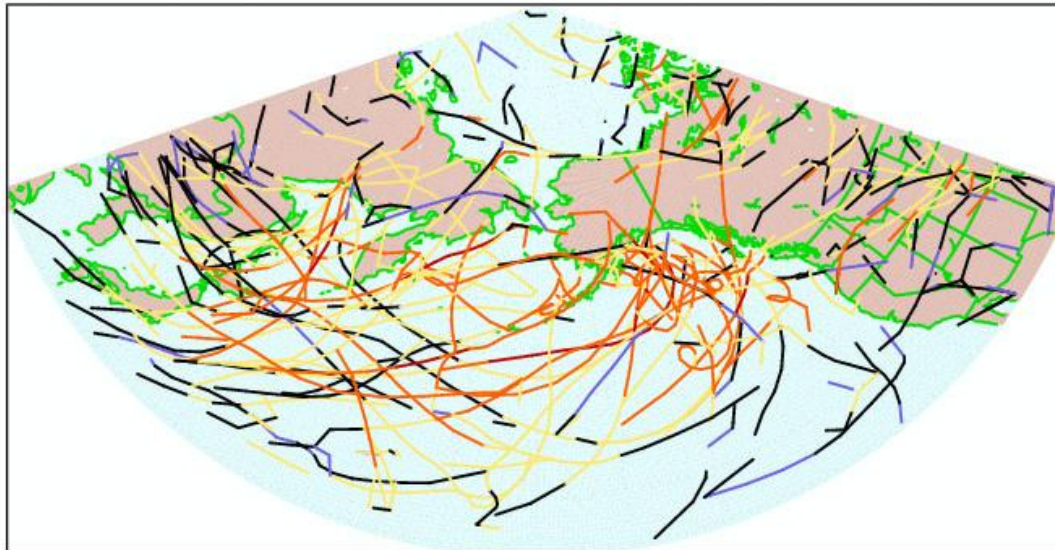
Storm Tracks--GR2--OND--1951



Oct-Dec 1951

**Storm tracks:
examples**

Storm Tracks--GR2--OND--2010



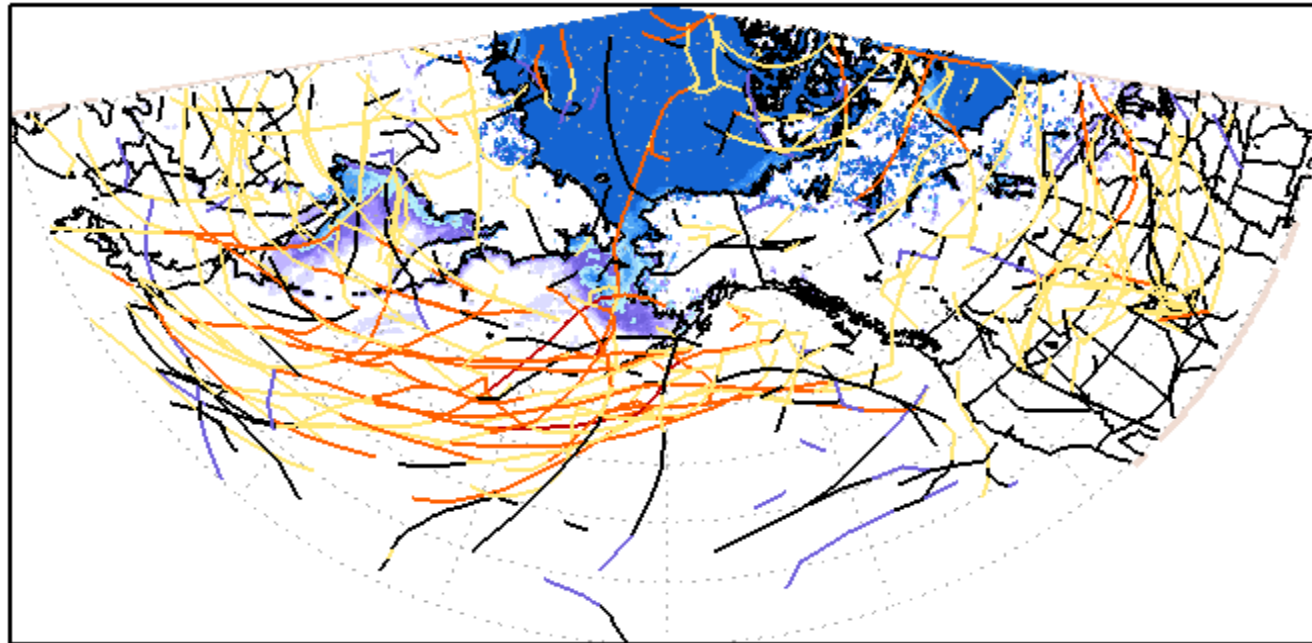
Oct-Dec 2010

Minimum Pressure
< 972 mb
972 mb - 992 mb
992 mb - 1004 mb
1004 mb - 1012 mb
> 1012 mb

Most recent 90-day storm tracks and sea ice coverage

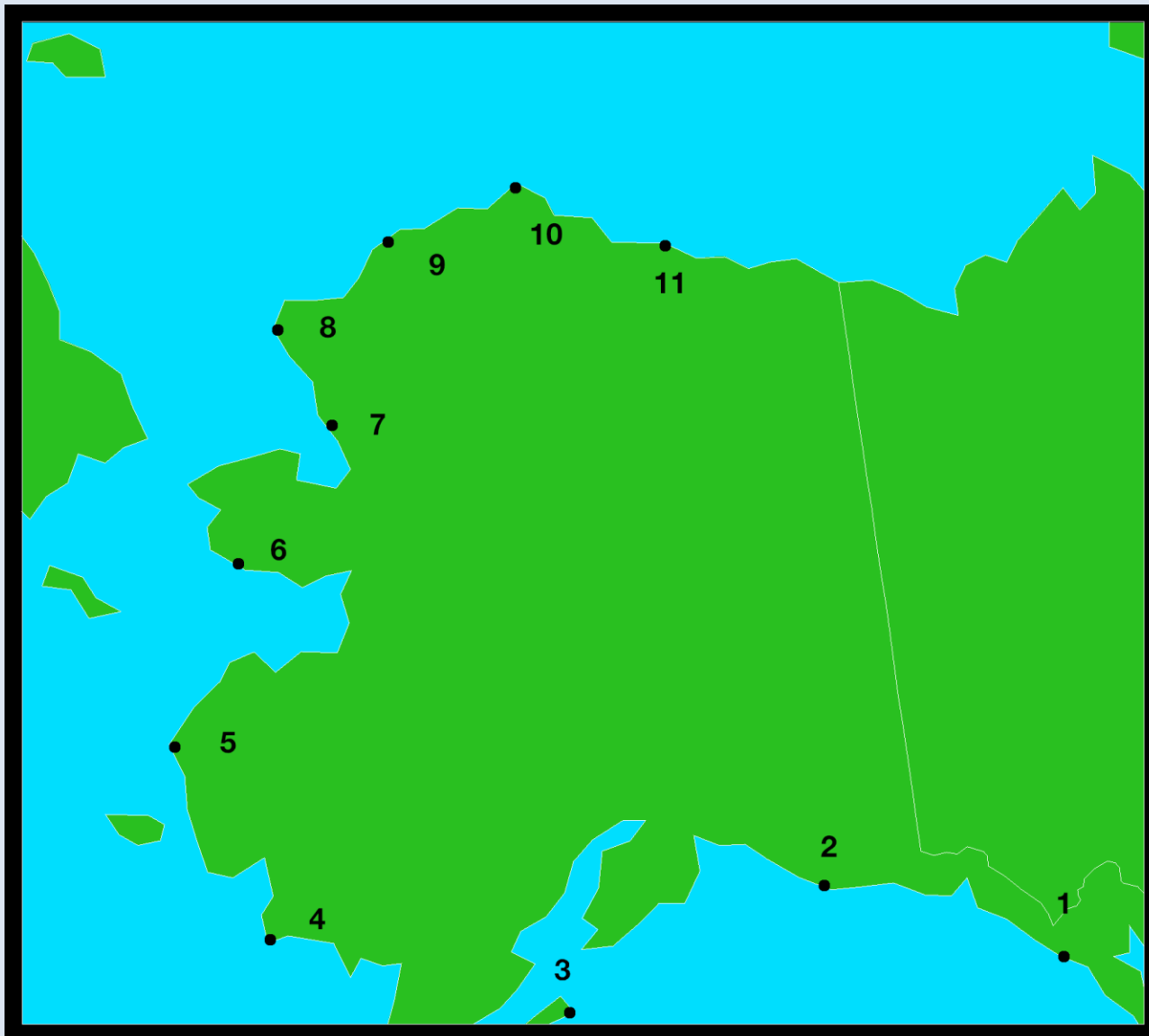
[March 20 – June 17, 2011]

90 day Sea Ice (fraction)—20MAR2011–17JUN2011



STORM TRACK KEY:
< 972 mb
972 mb – 992 mb
992 mb – 1004 mb
1004 mb – 1012 mb
> 1012 mb



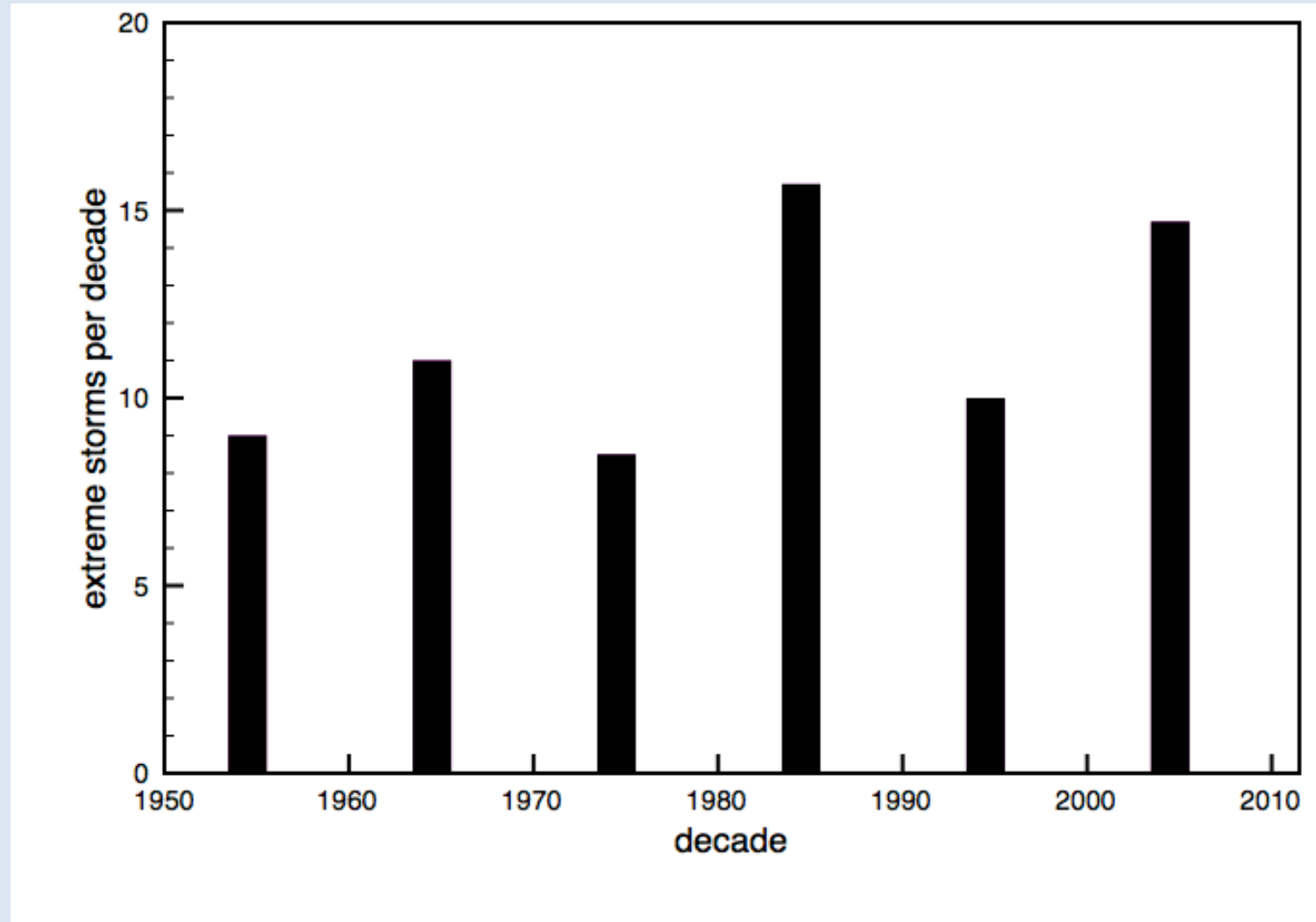


**For each
of eleven
Alaskan
coastal
points:**

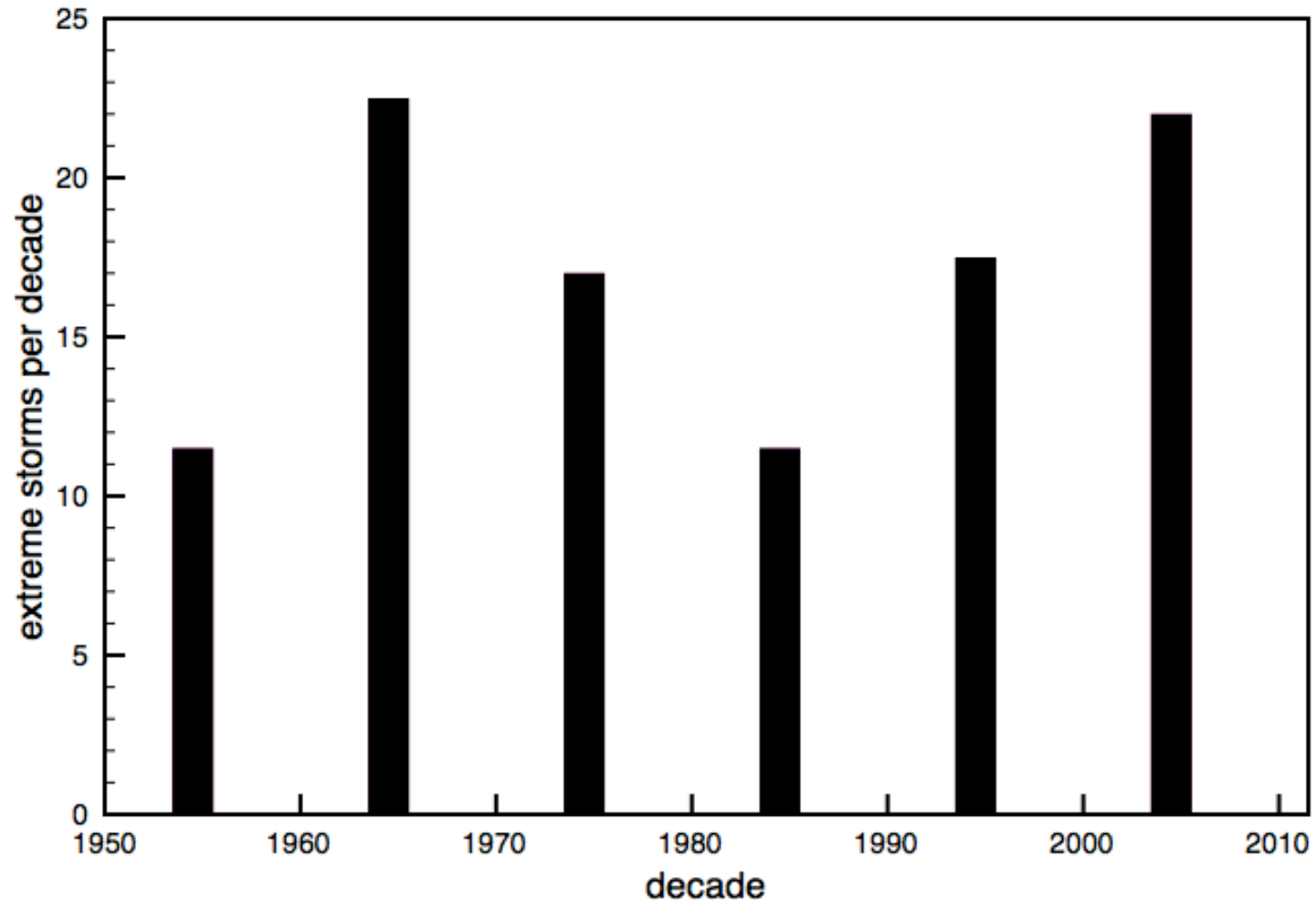
*all storms
within
250 miles
identified*

- **For each location, most intense 10% of all storms in each season were selected as the sample for analysis**
- **Storms were grouped into two categories:**
 - 1) **at least 100 km of open water immediately offshore**
 - 2) **less than 100 km “ “ “ “**

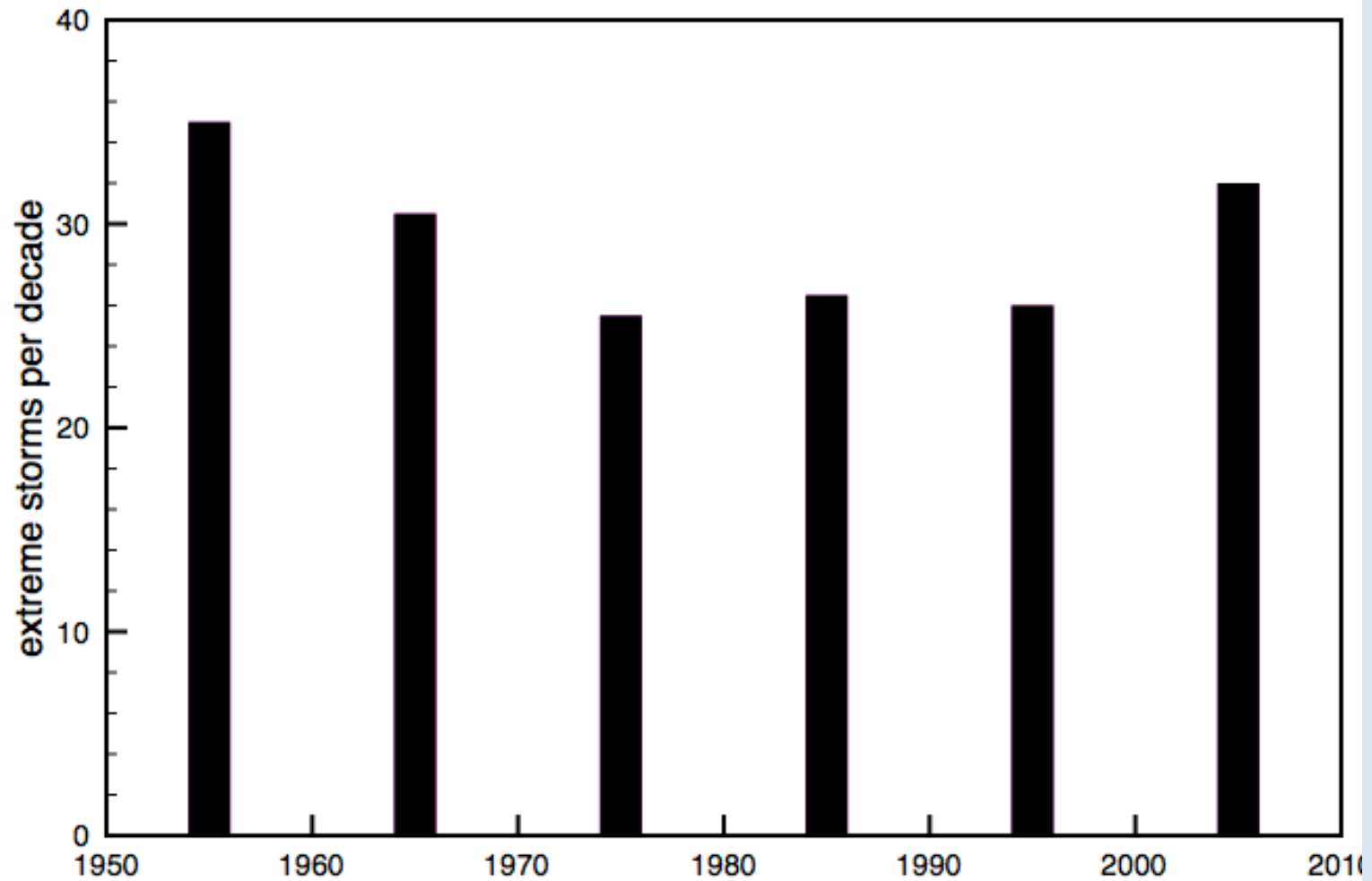
Autumn storm events by decade, northern Alaskan coast



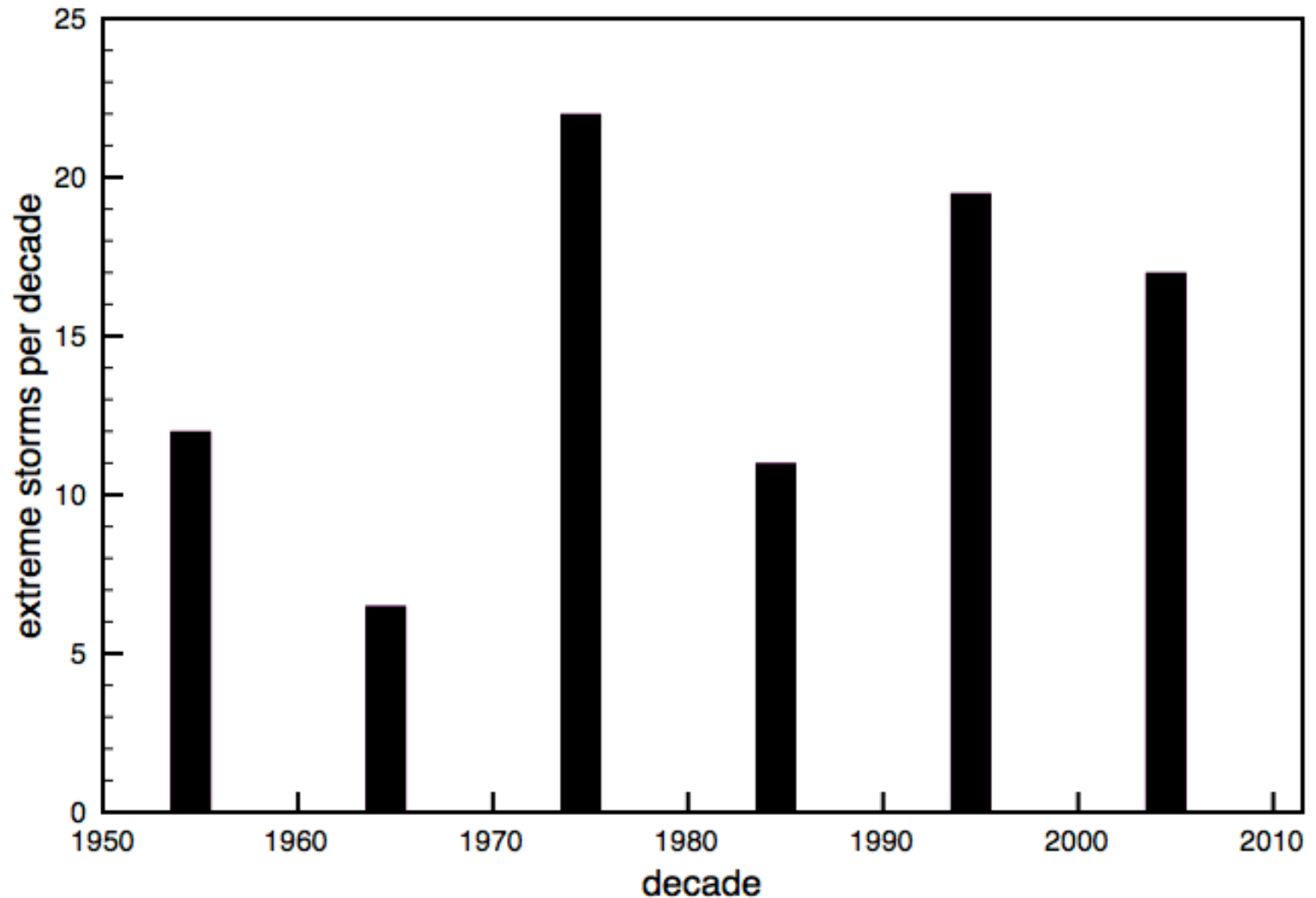
Autumn storm events by decade, NW Alaskan coast



Autumn storm events by decade, SW Alaskan coast



***Winter* storm events by decade, SW Alaskan coast**

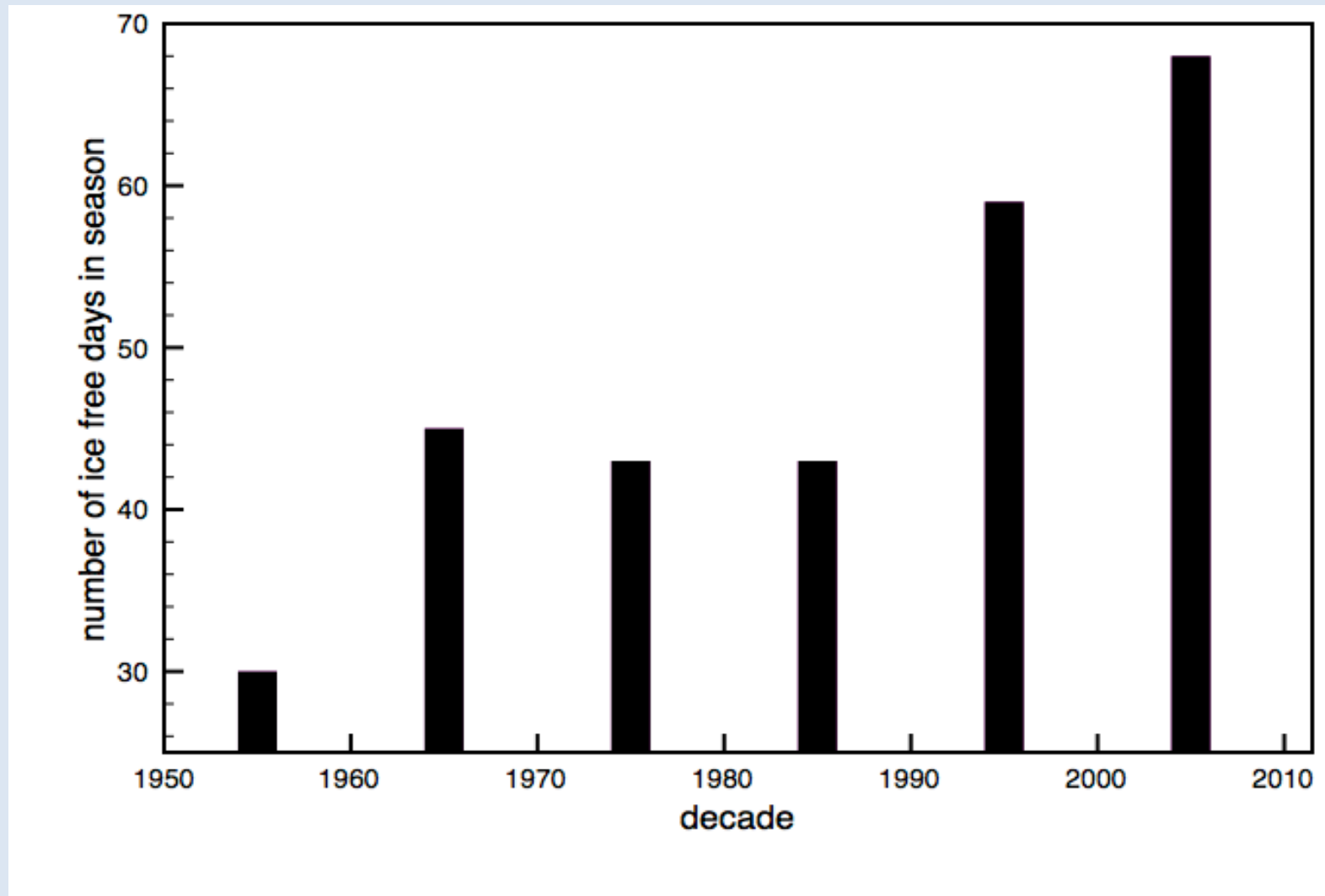


Trends of extreme storms by location and season

	DJF	MAM	JJA	SON	ANN
1	1.5571	-0.4735	-0.6435	0.8652	1.3054
2	0.5485	1.8005	-1.0303	-0.6085	0.7102
3	1.7472	-0.8602	-0.3084	-0.6568	-0.0784
4	1.2820	0.3968	-0.0734	-3.5560	-1.9505
5	1.1570	0.5535	0.1384	-2.1689	-0.3201
6	0.8202	-0.1700	-0.4701	1.4037	1.5838
7	0.6769	-0.4751	-2.0089	0.2534	-1.5538
8	0.0017	-0.3151	-1.4337	0.8669	-0.8802
9	0.3484	-0.1967	-0.3218	0.0167	-0.1534
10	0.4184	0.3984	-0.3201	1.0036	1.5004
11	0.8302	0.6418	-0.0167	0.5068	1.9622

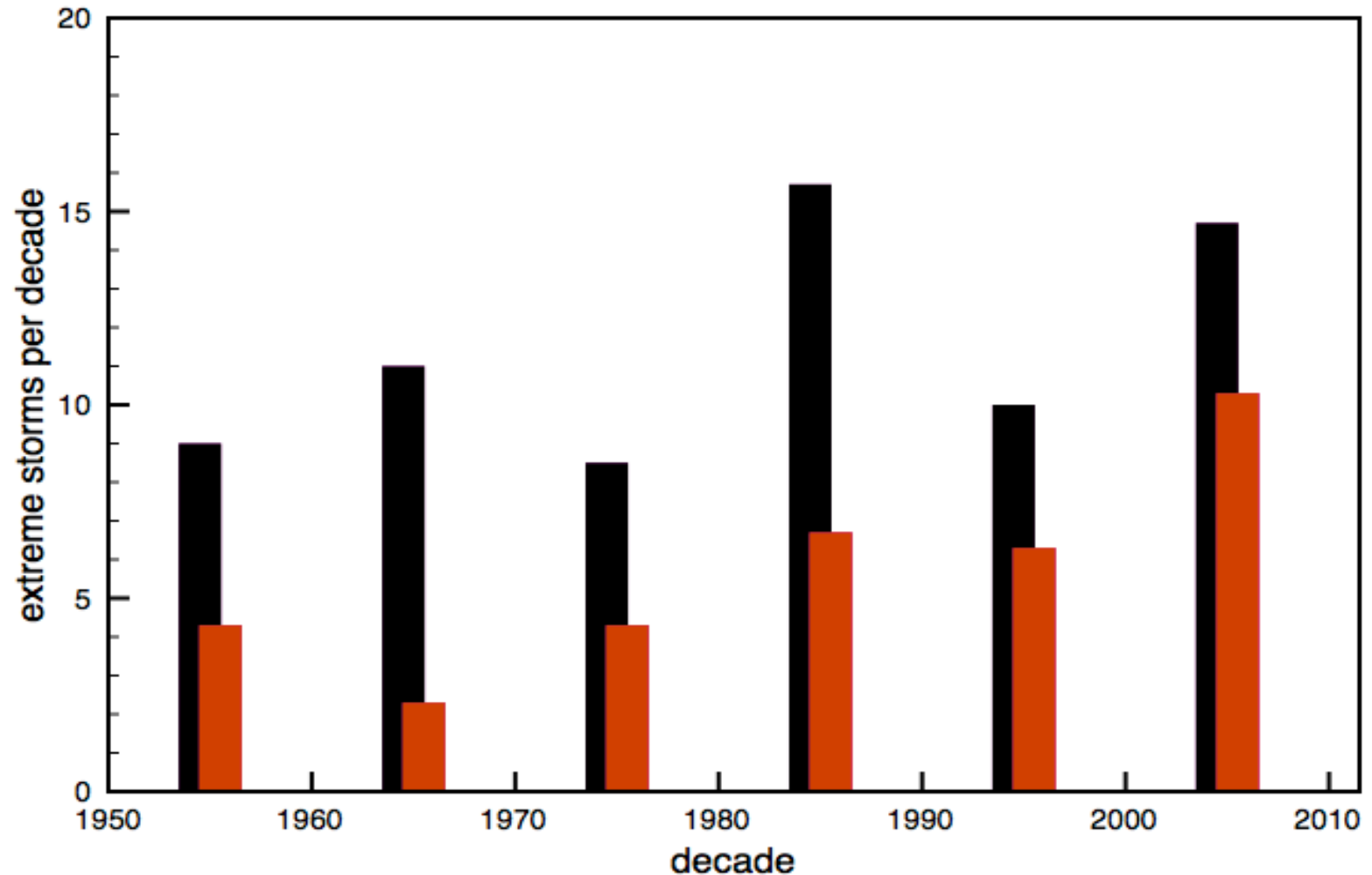
- *increases at all locations in winter*
- *northward shift in autumn*
(generally not statistically significant)

Decadal mean # of ice-free days in **autumn**: North coast



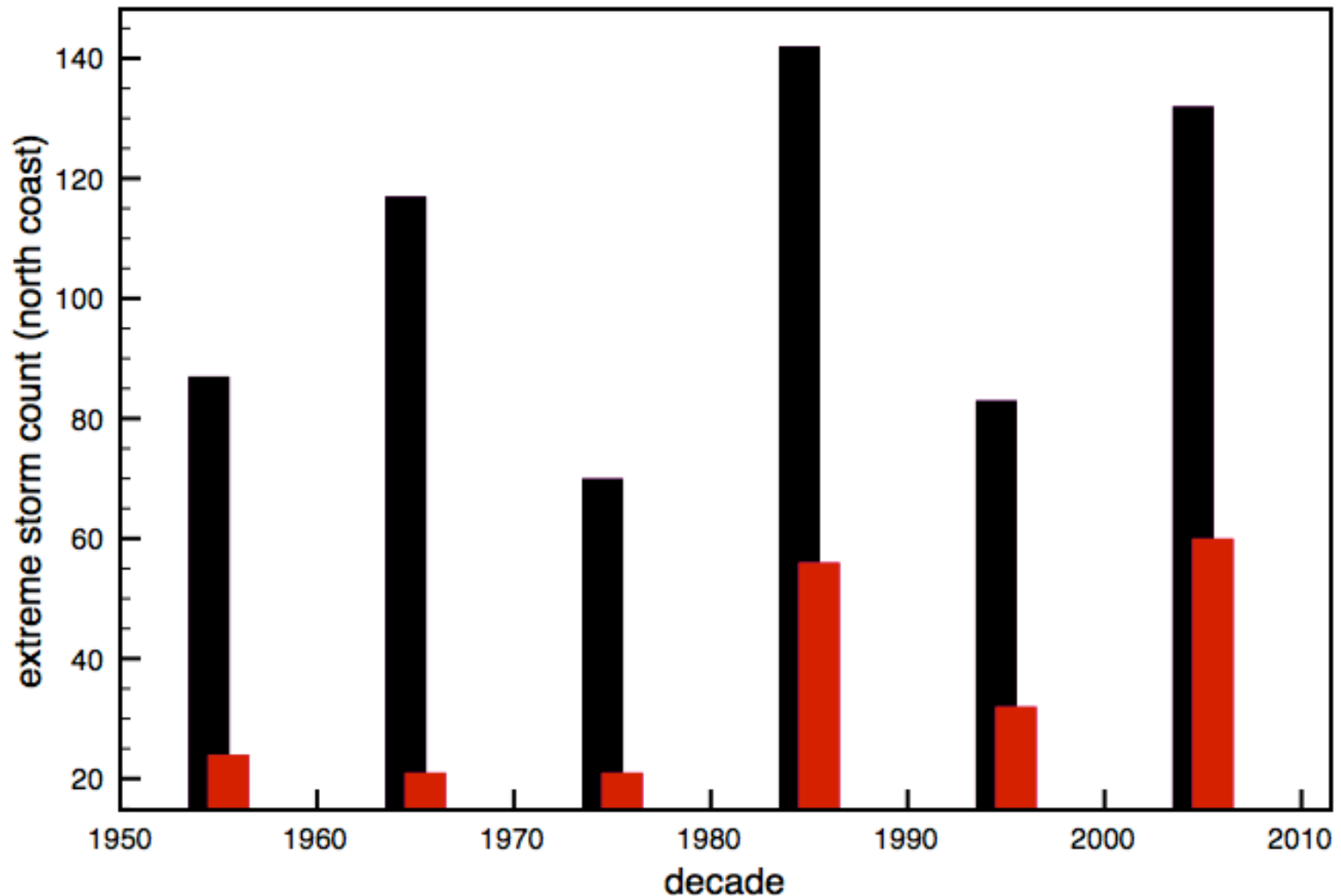
Autumn storm events by decade, northern Alaskan coast

[red = open water]

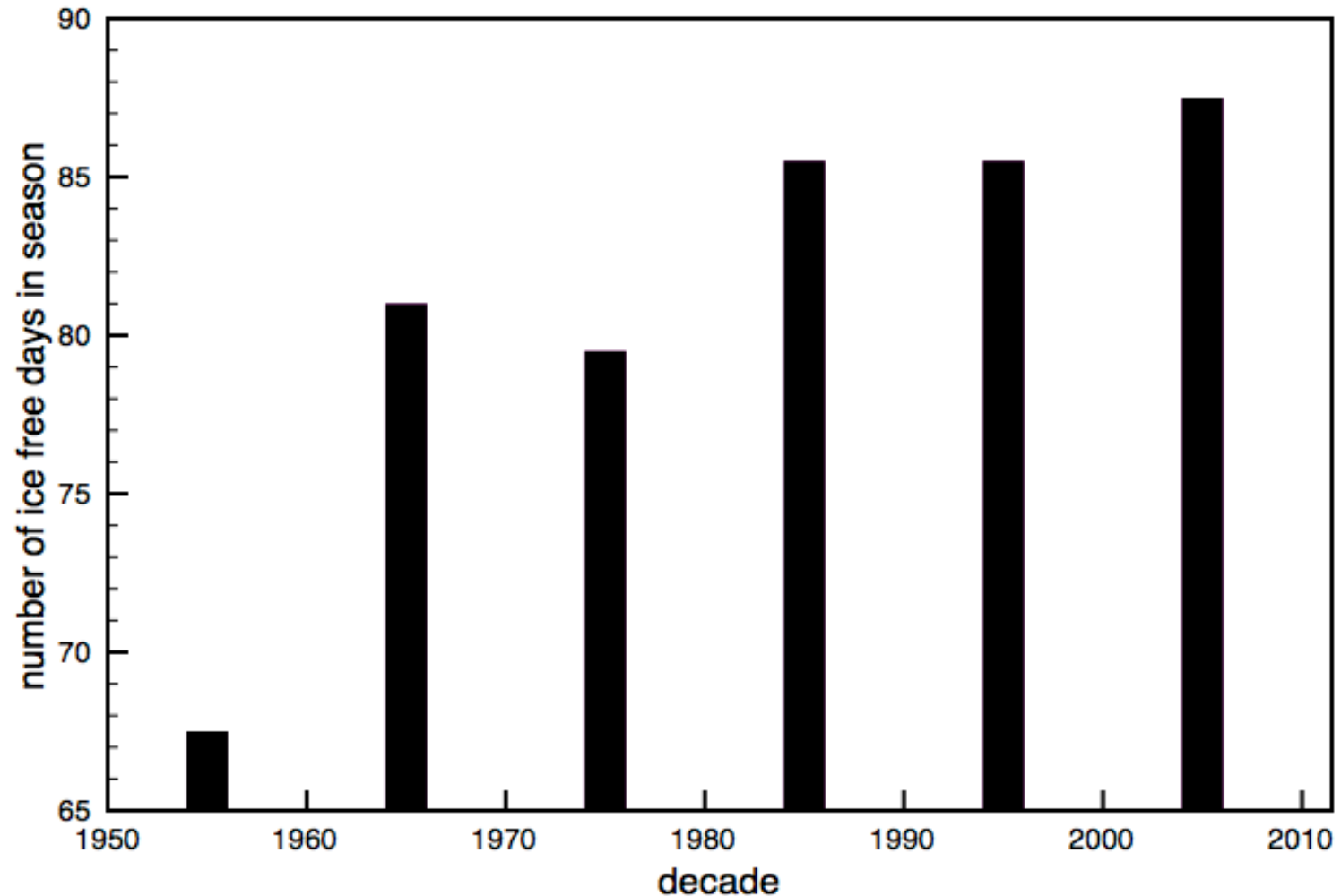


Storm events (*all seasons*) by decade, northern Alaska

[*red = open water*]

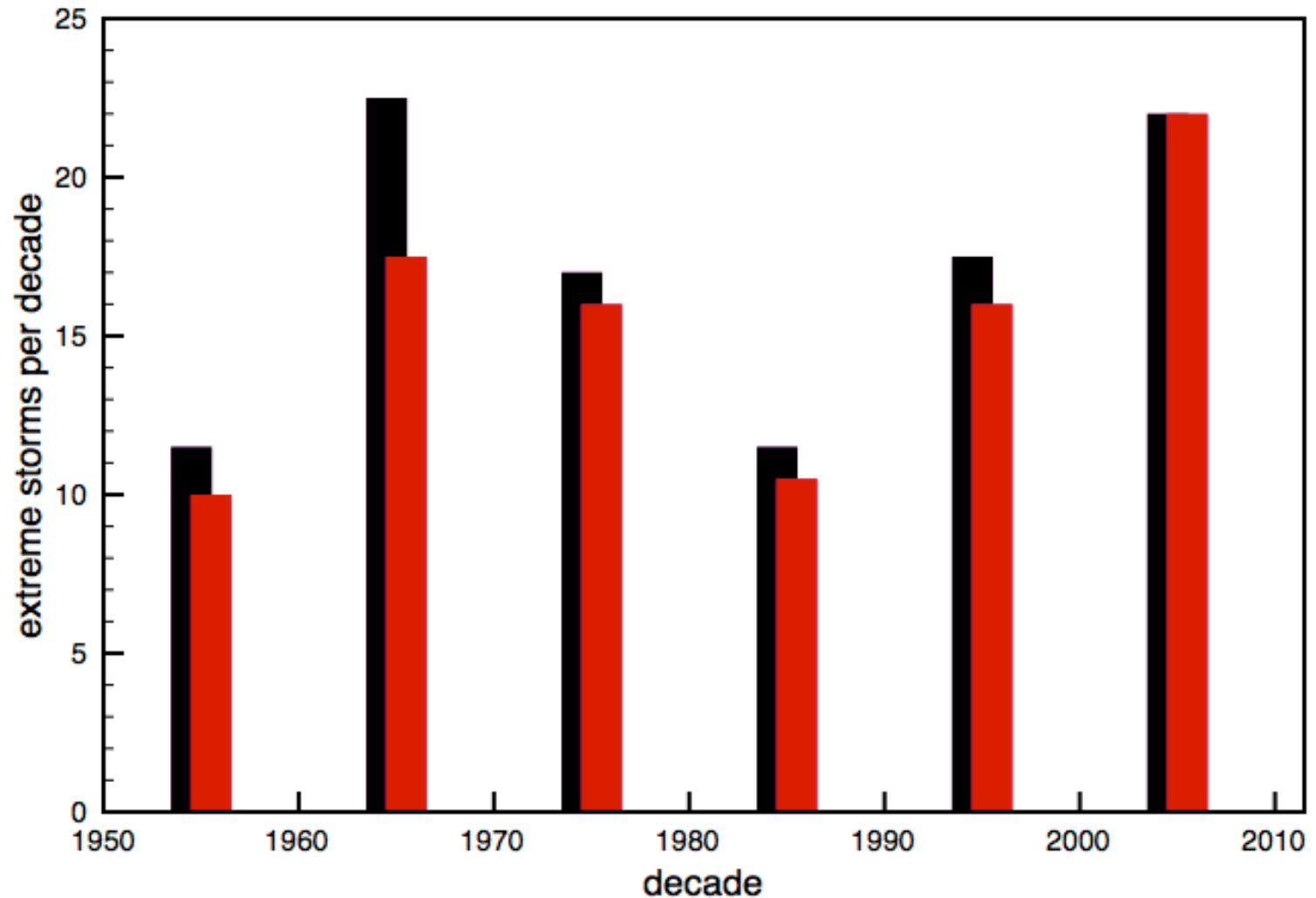


Decadal mean # of ice-free days in **autumn**: NW coast

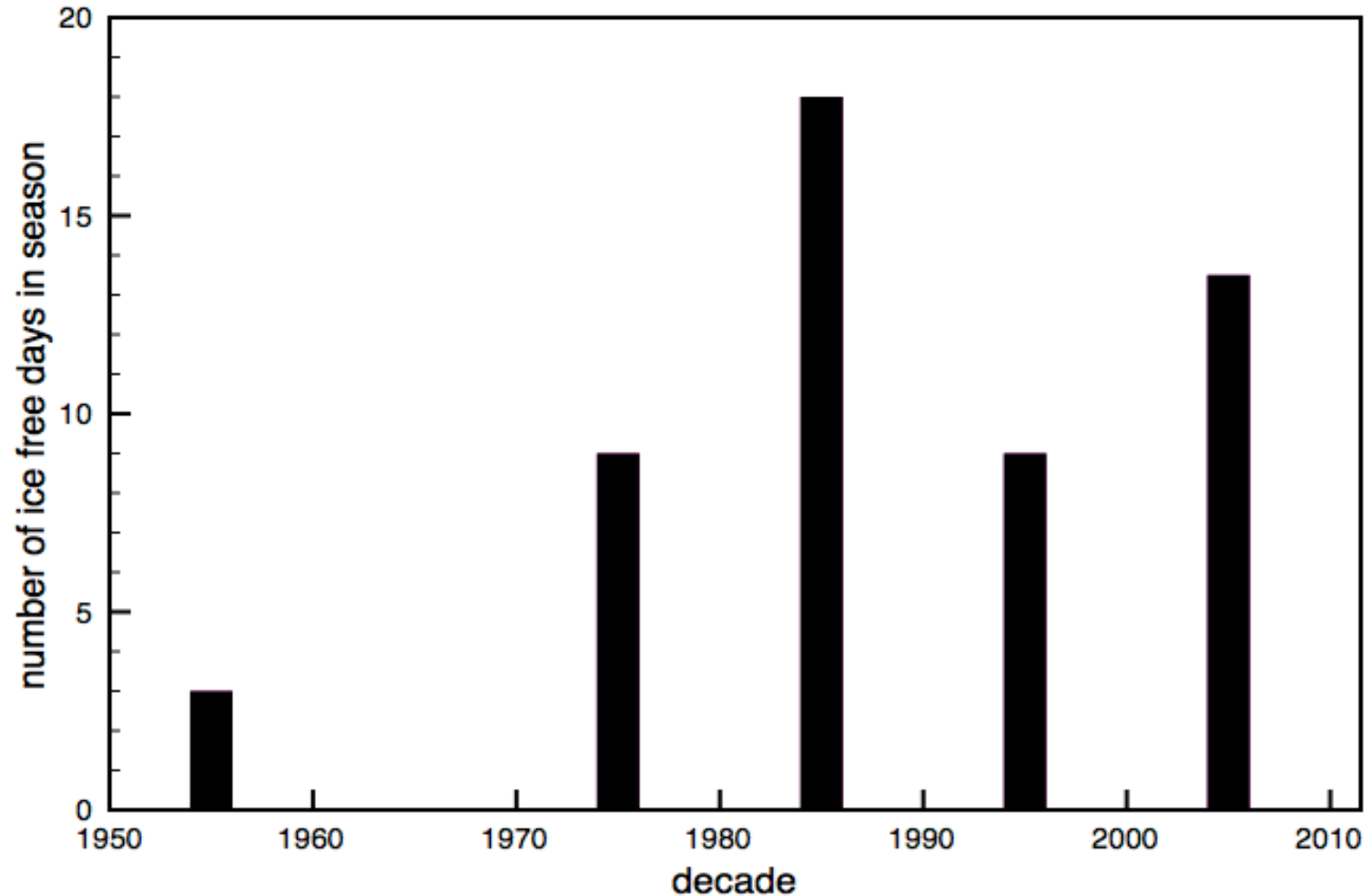


Autumn storm events by decade, NW Alaskan coast

[red = open water]

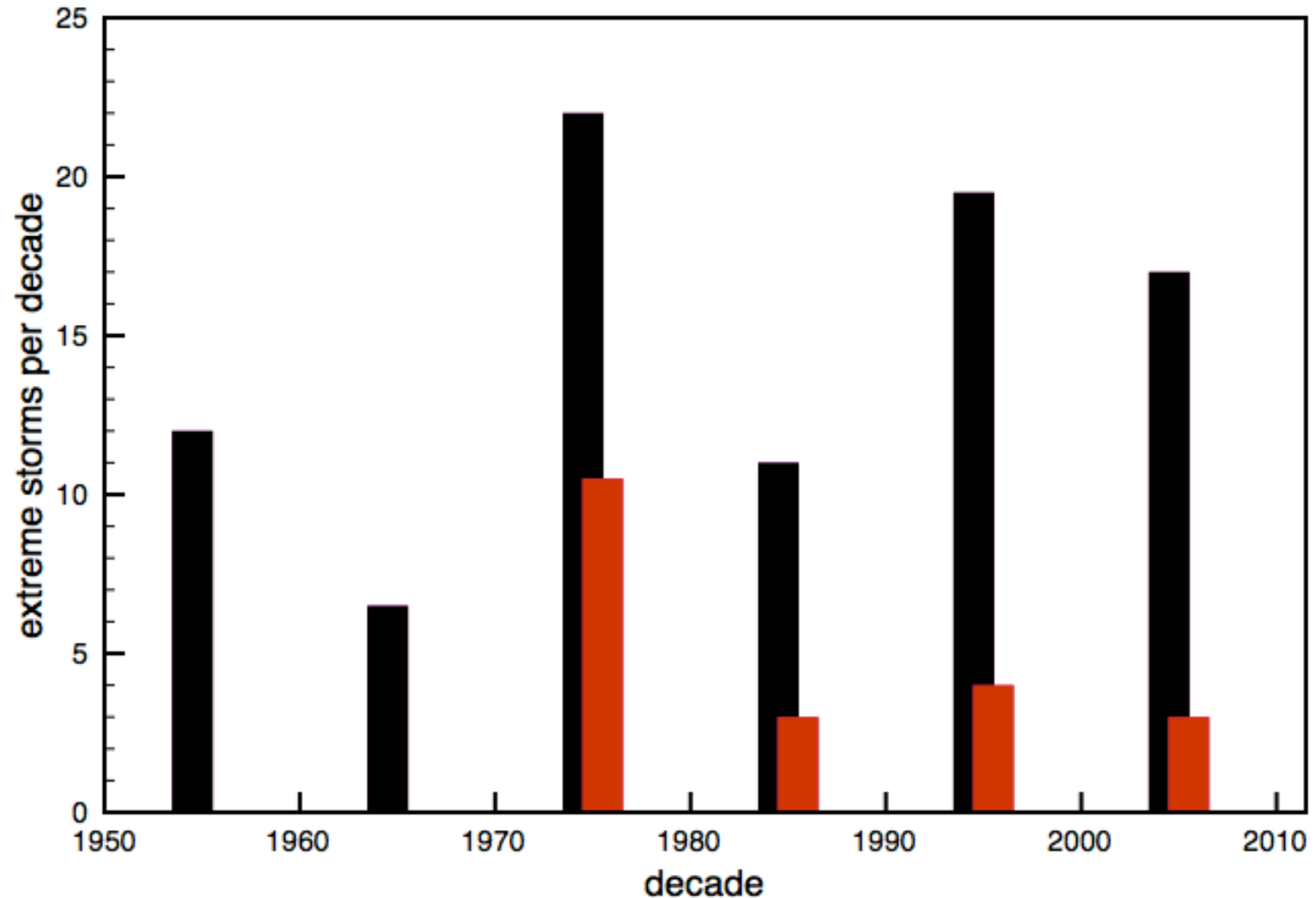


Decadal mean # of ice-free days in **winter**: SW coast



Winter storm events by decade, SW coast

[red = open water]



Conclusions

- **Frequency of intense storms in Alaskan coastal waters shows modest changes, but statistical significance is marginal**
 - increase in winter at all locations
 - northward shift in autumn
- **Length of the open water season has increased, especially along the northern and NW coasts**
- **Increase of coastal erosion and flooding is mainly a consequence of changes in sea ice**